

A PINNATE LEAF WITH RETICULATE VENATION FROM THE PERMIAN OF NEW SOUTH WALES

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(Plate I)

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Synopsis

A pinnate leaf with reticulate venation, *Dunedoonia reticulata* gen. et sp. nov. is described from the Permian Dunedoo Formation of New South Wales. No structural details are preserved. In megascopic form this leaf closely resembles some species of the Mesozoic Bennettitalean genus *Dictyozamites* and also some species of *Linopteris* from the northern Carboniferous flora.

INTRODUCTION

Many palaeobotanists have remarked on the paucity of genera in the Permian floras of Gondwanaland. At most fossil localities the majority of plant remains are *Glossopteris* and *Gangamopteris* leaves. Species of other genera, with the exception of *Phyllothea*, occur rarely and in very small numbers. Dana (1849) remarked that *Glossopteris* formed perhaps 99% of all fossil leaves found in the Newcastle and Illawarra coalfields of New South Wales. Pant and Singh (1974, p. 29) noted that the small number of genera was counterbalanced by the large number of species of *Glossopteris* and *Gangamopteris*. Approximately 114 species of *Glossopteris* and 33 species of *Gangamopteris* have now been described. Many of these are based on the characters of the cell structure in leaf cuticles.

Under warming conditions plant communities become undersaturated. This leads to diversification and ecological expansion and also to the emergence of evolutionary novelties (Krassilov, 1974, p. 175). *Glossopteris* and *Gangamopteris* appear to have had sufficient genetic plasticity to have rapidly evolved a multiplicity of adaptations to fill many ecological niches in the ameliorating climate following the Permo-Carboniferous glaciation across Gondwanaland. However, the majority of Permian fossil plant localities are associated with coal deposits and thus may represent a limited range of environments. The large number of described fossil pollen grains, seeds and fragments of cuticles indicates a presence, probably in upland areas, of many other plants which did not grow in the coal-forming environments.

The leaf described below, while incomplete and lacking structural details, is considered important as it adds further diversity to the known Permian flora of Gondwanaland.

GEOLOGICAL HORIZON

The specimen came from a quarry, now closed, on the property of Mr Mervyn Nott located 10 km WSW of the township of Dunedoo and 4 km ESE of the village of Cobborah.

The geology of the area has been studied by Kemp (1973). The sequence from Permian through to Early Jurassic in the area is mostly horizontal and rests unconformably on the ? Silurian-Devonian Tucklan Beds (Offenberg, 1968). The sediments were deposited on the north-western edge of the Sydney

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Basin on a structural high which separated the Sydney Basin from the Great Artesian Basin. The basal Dunedoo Formation (Higgins and Loughnan, 1973) of Permian age has a maximum thickness of 30 m but the average is much less. The Nott quarry is situated at the top of the Dunedoo Formation. The rock types in the quarry are white to cream coloured laminated claystones and porcellanites. The plant fossils, which are mostly *Glossopteris* leaves, are exquisitely preserved as impressions of yellow, red or brown limonite on the pale coloured matrix.

The abundance of kaolinite, a mineral that is generally characteristic of the humid tropics and sub-tropics, in the basal beds tends to suggest that development of the formation was accompanied by warm humid conditions (Higgins and Loughnan, 1973, p. 35).

The overlying Early Triassic Boulderwood Conglomerate (Higgins and Loughnan, 1973) is exposed at the top of the quarry. Kemp (1973) broadly dated the Dunedoo Formation as Permian. The Dubbo Geological Sheet of the Geological Survey of N.S.W. shows the area as "undifferentiated Permian". The forms of *Glossopteris*, *Vertebraria*, *Neomariopteris* (= *Sphenopteris* in part) and *Phyllothea* found in the Dunedoo Formation are similar to those from the Illawarra and Newcastle Coal Measures which are Late Permian in age.

EXPLANATION OF PLATE

COMBINED DIAGNOSIS. Leaf pinnate, ovate; rachis longitudinally wrinkled and pitted. Leaflets opposite or sub-opposite, entire; base truncate or slightly auriculate; attached by middle portion of base to upper edge of rachis. Venation reticulate, with no midrib.

DESCRIPTION. Leaf pinnate, ovate. Length preserved 10 cm. Tapering upwards from 8 cm in width at the broken base to 5 cm at the broken top. Rachis 3 mm in width at the lower end and gradually tapering upwards; surface longitudinally wrinkled and marked with irregular sized pits and tubercles. It is not known if this feature is original or a result of preservation.

Leaflets opposite or sub-opposite; almost at right angles to the rachis; oblong-ovate, obtuse, entire; base truncate or slightly auriculate, the upper angle of the base less lobed than the lower angle. Leaflets abruptly constricted at the base and attached by the middle part only of the lamina to the upper edge of the rachis. Each leaflet overlaps slightly the leaflet below. Length of leaflets 3.5 cm–2.5 cm; breadth 1.8–1 cm, decreasing in size up the rachis. Several veins arise from the attached part of the base and radiate and anastomose into the lobes and through the lamina forming polygonal meshes in the lobes and near the margins and elongated parallel meshes elsewhere. There is no midrib. Number of veins measured at right angles across mid-portion of lamina approximately 18 per cm.

HOLOTYPE. The pinnate leaf on Specimen No. F56472, The Australian Museum Fossil Collection, Sydney, N.S.W.

Also on this specimen are small leaves comparable with *Glossopteris angustifolia* Brongn., *G. browniana* Brongn., *G. communis* Feist. and *Neomariopteris lobifolia* (Morris) Maithy.

TYPE LOCALITY. M. Nott's Quarry, "Oakfield", Dubbo Road, Cobborah, N.S.W.

HORIZON. Dunedoo Formation. Permian, probably Late Permian.

COMPARISONS. Several genera of Late Palaeozoic and Mesozoic plants are known which have pinnately compound leaves and reticulate venation.

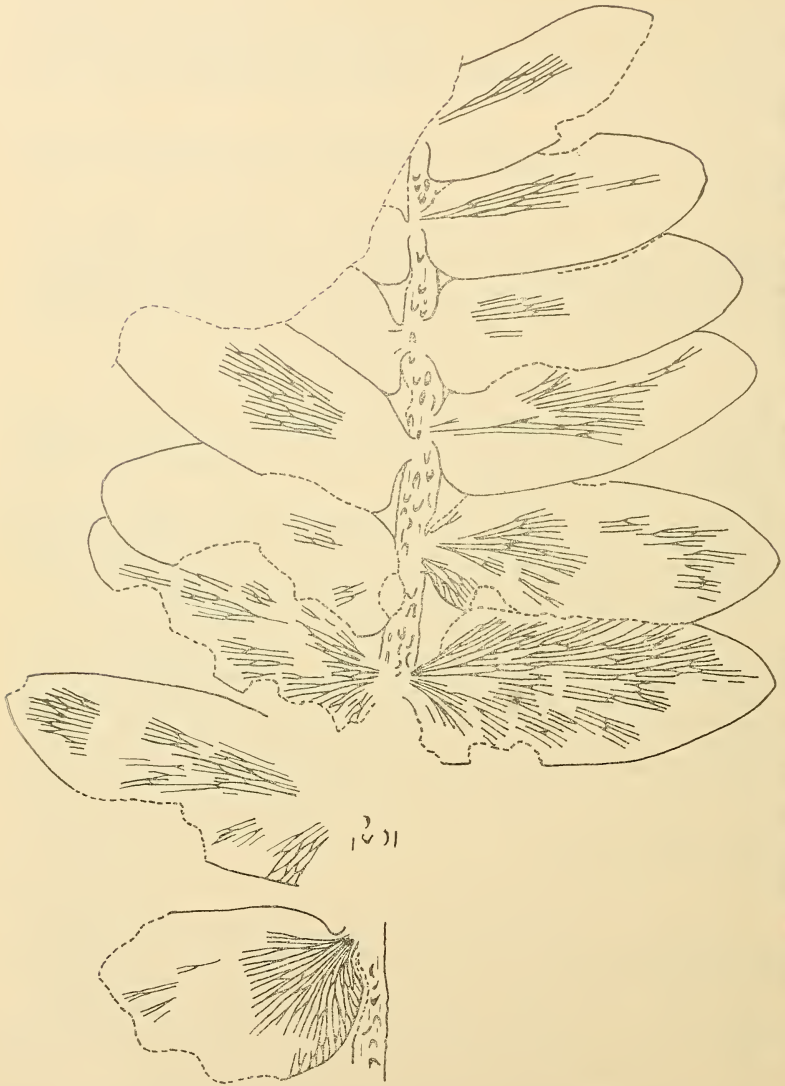


Fig. 1. *Dunedonia reticulata* gen. et sp. nov. Holotype. Specimen No. F56472, The Australian Museum Fossil Collection. $\times 2$

Lonchopteris Brongn., a pteridosperm genus from the Carboniferous of Europe and North America, and *Weichselia* Steihler, a possible fern genus from the Jurassic of Europe, North America, Russia and Japan, are tripinnate and bipinnate respectively. They both have reticulate venation but the pinnules are attached by the whole of their base to the pinna rachis. *Emplectopteris* Halle from the Palaeozoic of China resembles *Lonchopteris* Brongn. but lacks the well defined midrib that the latter possesses.

Linopteris Presl. is a tripinnate pteridosperm genus from the middle to Late Carboniferous of Europe and North America which resembles *Neuropteris* Brongn. except for having reticulate venation. The presence of a midrib appears to be a variable feature within species. The shape of the pinnules and the method of attachment to the pinna rachis in some forms of *Linopteris obliqua* Bunbury and *L. neuropteroides* Geinitz (Crookall, 1959, Figs 71 and 72) are similar to *Dunedoonia reticulata*. They differ in the form of their venation and the alternate attachment of the pinnules. Other species bearing a similar resemblance are *Reticulopteris munsteri* (Eichwald) Gothan and *Neuropteris semireticulata* Josten from the Late Westphalian of Germany (Josten, 1962, Fig. 4a-d).

Bunbury (1861, p. 33, plate X, Fig. 3.) described as "*Felicites* (qu *Glossopteris* sp.?)" a fragment of a pinnate frond from the Permian beds of Nagpur, India. Each oblong or lanceolate leaflet was attached by the whole of its base to the rachis. The venation consisted of a midrib and secondary veins which were dichotomous and possibly reticulate. This leaf differs from *Dunedoonia reticulata* in the shape and attachment of its leaflets and in having a midrib.

Pant and Singh (1974, Fig. 1F) show a specimen of *Gangamopteris* cf. *cyclopteroides* var. *cordifolia* Feist. with an apparent opposite attachment of leaves on an axis. Individual leaflets of *Dunedoonia reticulata* are unlike any known species of *Gangamopteris*.

Cycadopteris scolopendrina Ratte from the Late Triassic Ashfield Shale of the Sydney Basin is a pinnate leaf similar only in outline to *Dunedoonia reticulata*. Specimens in the Australian Museum which were described by Ratte (1887) and Etheridge (1889) are coalified compressions in which some cell structure is preserved. The mode of attachment of the pinnules to the broad striated pinna rachis cannot be determined. Venation in the pinnules consists of indistinct secondary veins leaving a median groove at an angle of approximately 45°.

Species of *Betrychiopsis* Kurtz (= *Gondwanidium* Gothan) occur in the earliest Permian floras of Gondwanaland. These are pinnate leaves but have irregular shaped leaflets with dichotomous venation.

The megascopic diagnosis of the genus *Dictyozamites* Oldham by Harris (1969, p. 87) is "Leaf simply pinnate; pinnae attached near the upper margin of the rachis; base of lamina contracted and usually asymmetric. Veins diverging from point of attachment, forking and anastomosing frequently". Anatomical details of this Bennettitalean genus are known from petrifications (Bose and Kasat, 1972) and compressions (Menendez, 1966; Gupta and Sharma, 1968; and Harris, 1969). Species of *Dictyozamites* have been described from India, Northern Europe, Japan, Korea, Tierra del Fuego and Santa Cruz Province of Argentina. The size, shape and venation is variable. In most species the pinnae are alternate on the pinna rachis but Gupta and Sharma (1968, pp. 25-26) note some specimens resembling *D. falcatus* Oldham with opposite attachment.

Had the present leaf been found in Mesozoic strata it would, without hesitation, have been placed in *Dictyozamites*. However, because of the great difference in age and the lack of information on its structure I have placed it in a new genus.

DISCUSSION

"Mixed floras" in which genera of the Euramerian or Laurasian flora are associated with otherwise typical *Glossopteris* floras are recorded from South America and South Africa (Chaloner and Lacey, 1973). During Late Palaeozoic time Gondwanaland moved as a unit across the south rotational pole as indicated by glaciation (Crowell and Frakes, 1975) and by polar wandering data from palaeomagnetic studies (McElhinny, 1973). Glaciation commenced during the Carboniferous in South America and then-adjointing South Africa, and migrated to India, Antarctica and Australia in the early Permian. Amelioration of the climate in South America and South Africa apparently occurred early enough to allow some migration of the northern Carboniferous flora southwards to these areas. In India, Antarctica and Australia where the glaciation persisted into the Permian no plants of close relationship to the northern flora have been recorded. Plants previously ascribed to the northern genera *Sphenopteris*, *Annularia*, *Sphenophyllum* and *Cordaites* are now believed to be generically distinct and have been placed in the genera *Neomariopteris* Maithy, *Lelstotheca* Maheshwari (= *Stellotheca* Surange and Prakash), *Trizygia* Royle and *Noeggerathiopsis* Feist. respectively. Similarities may be due to parallel evolution or development from very remote ancestors. A relationship of *Dunedoonia reticulata* to the neuropterid genera *Linopteris* and *Reticulopteris* is unlikely. In gross form *D. reticulata* is closest to *Dictyozamites* which occurred much later in geological time.

The origin of the Cycadophyta is obscure. The presence of many Cycadales and Bennettitales in the Triassic of Australia (Gould, 1976) and other parts of Gondwanaland lends support to Plumstead's suggestion that both these groups of plants had their origin in the *Glossopteris* flora (Plumstead, 1973, p. 200).

The discovery of structurally preserved specimens of *Dunedoonia reticulata* would show whether this plant was an early cycad or an evolutionary novelty.

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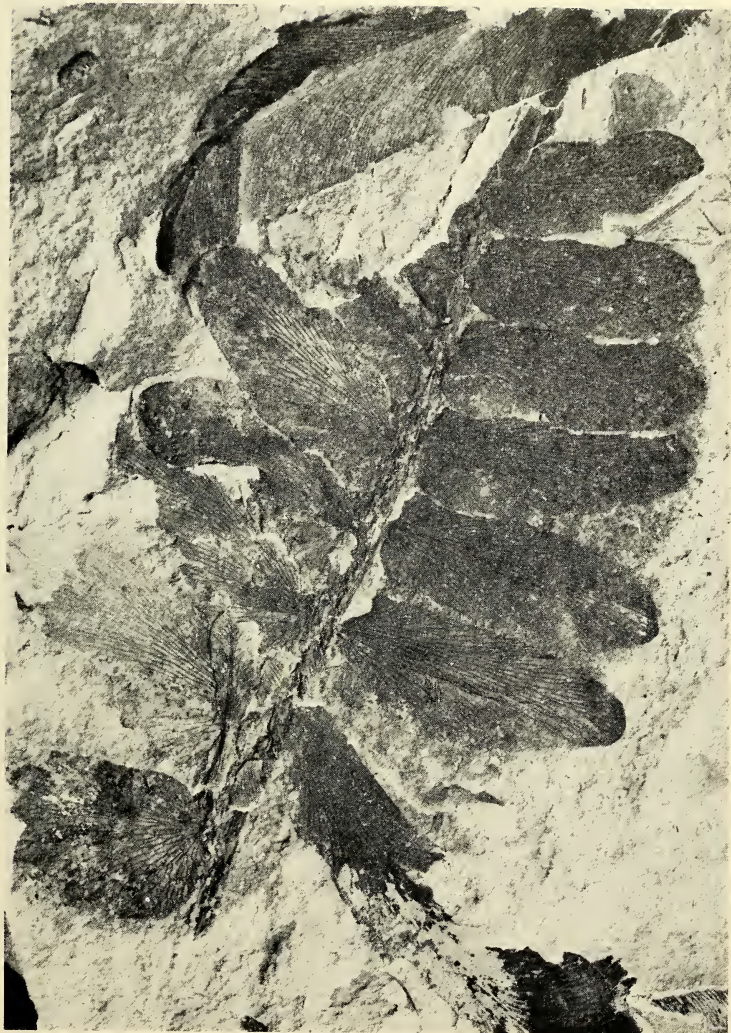


PLATE I

Dunedoonia reticulata gen. et sp. nov. Holotype. Specimen No. F56472, The Australian Museum Fossil Collection. $\times 1.5$.